

SOME NEW
INQUIRIES

TENDING TO THE

IMPROVEMENT

NAVIGATION.

By J. A. GENEVOIS,

Minister in the Canton of BERN.



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Minister in the Canton of Bern in 1848.

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**THE HONOURABLE THE
COMMISSIONERS
OF HIS
MAJESTY'S NAVY,**

GENTLEMEN;

THE following is the Memoir which you required of me on the 4th of *August* last, in order to enable you to lay before the Lords of the Admiralty an Account of that Part of my Work which relates to Navigation. The Difficulty attending the translating this short Account into *English*, has, in some measure, retarded the Presentation of it. I doubt not but the Stile will need your utmost Indulgence: However, I flatter myself that it will be intelligible, for which Reason I am constrained to rest satisfied with it, not having been able to procure a better.

Being persuaded, Gentlemen, that a mature Examination of my Principles will easily occasion them to triumph over that Prejudice which

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is naturally incident to new Discoveries, unless presented by Men already celebrated by their Works; I thought myself obliged to cause this Memoir to be printed, not with a View to a direct Publication of it, but in order to its being so, if it should hereafter be thought requisite. The Printing of it has been executed in the most private manner possible; and I shall not distribute a single Copy of it, except to such as are appointed Judges of my Work, and who have favoured me by their Promise of observing an inviolable Secrecy.

Permit me, Gentlemen, to assure you of the strong Confidence I have, that you will examine it without Prejudice, and with that Attention and Candour which the Importance of those Things that are the Subjects of it deserve, and, perhaps, to a certain Degree, the Person who has the Honour of laying them before you. His Design is to render himself serviceable to Mankind. Can there be a more worthy Object pursued on his Part, seconded, Gentlemen, on yours; and moreover agreeable to the great and distinguished Character of your Nation?

In Confidence of this, and with due Respect, I have the Honour to be,

Gentlemen,

Your very Humble

and very Obedient Servant,

London, 7th

Sept. 1760.

J. A. GENEVOIS.



SOME NEW INQUIRIES

Tending to the
Improvement of Navigation.

IN order to give a general idea of my work, and of the services that it may render to Navigation, I propose to consider two things in the course of this memoir; First, I shall describe the Oars that I recommend; and, secondly, the Powers or Springs that put them in motion.

PART I.

I find in the common Oars ten essential faults, p. 10. The Supreme Geometrician, the Wise Author of Nature, not having given a pattern resembling these in any living creature, I look upon it as a strong objection against the goodness of the present method. I will enumerate their imperfections in a more proper place; let it therefore suffice to observe here, that if a boat is moved with as great a degree of velocity as the Rower moves his Oar, the Oar produces no effect; and if it is moved with a greater velocity,

the Oar must rather tend to slacken than to augment its motion: the greatest effort of the Oar is before the motion of the boat, and from that very moment one must always deduce from its energy the swiftness acquired by the boat. Besides, Oars are incapable of being employed in a large ship.

The Oars, a pattern of which our wise Maker has given us, are either the tails of fish, or the feet of swans and ducks. I speak, p. 23 and 38, of the imitations of the first. I confine myself, in this memoir, to propound the second, as the easiest and most practicable.

The muscles which nature makes use of to put them in motion have this advantage, that they work either swiftly or slowly, according as the creature pleases; so that, whatever his swiftness may be, as it is not equal to that which he can give, by a sudden stroke of his foot, this stroke will always add a new degree of swiftness.

It is notorious, that the creature bends its feet in bringing them forwards, the membranes are closed, and almost no longer resist the water. This elegant mechanism of our Creator man should have imitated; and it is the same I make use of, as being absolutely free from the ten imperfections I have before spoken of.

This is the construction of it, which join together the two qualities of the pattern; *viz.* the Swiftness, and the Non-resistance in the return. I perform the first by the means of a spring; the second by either of the following constructions.

CONSTRUCTION I. Fig. I.—AB is the end of the Oar, having the cross-sticks EF and CD. The shelves EG, CB, and GF, BD, can close forward, turning upon hinges into GB, but open as they are in the figure, they are steadfast, and supported by the sticks. One may easily understand that this Oar, like a duck's foot, will close as it comes forward, and will open

as

as it is drawn back, provided the two extremities in FD and EC are not quite close, but decline a little.

CONSTRUCTION II. Fig. II.—I imagine that within the space ABEF is the stern of the boat, and the part EFCD is sunk into the water. CD is a cross-line, which strengthens, in the lower extremity, the juncture of AC and BD. EF, EF, are shelves, or boards, which, in the situation of the figure, are close, but which open as they move towards the water, being suspended in EF, and made heavy enough, by the iron work, to come naturally to the situation of the figure. Both these Constructions have each of them their private uses, which, for shortness sake, I will not examine in this place.

Second CONDITION of PATTERN.

It has been suspected (see *Borelli*, *Desaguliers*, and especially *J. Bernouilli* *), that wise Nature does not use double or treble vital spirits to produce a double or treble effort. Were this suspicion groundless, we must confess that art must have, in this respect, a pre-eminence over nature herself. If a duck wants a quadruple effort to work with its foot a motion four times swifter, he has not the same advantage that we have in working by means of a spring. But,

* Omnis difficultas in motionibus animalibus peragendis unice, ut credo, provenit a dispendio spirituum animalium. Verum spiritus in longe minori ratione absumuntur, quam sunt pondera elevanda. Ita ut si, ex gratia, elevandum sit pondus duplum, non ideo etiam sequantur duplo plures spiritus animales.—Quantitates spirituum animalium, uno momento absumptorum haberi possunt ex ipsa æquatione, ad Hyperbolicam. Vide dissertationem Physico mechanicam Joh. Bernouilli, præfixam operi Alph. Borelli de motu Animalium, in §. 18 & 19.

the better to understand this essential part of my work, it is necessary to observe the following truths :

1st. The power of a Spring, in the time it is unbent, is always equal to the bending power.

2dly. A Spring unbent exerts at once, and with the greatest swiftness, all its powers: a bow bent slowly, and after many different efforts, conveys at once all its powers into an arrow, which is shot with the quickest velocity.

C O R O L.

The consequence is, that the Spring is wonderfully efficacious to set Oars in motion, since whatever the swiftness of the boat may be, and how small soever the power is which is given to the Spring when it is unbent, this power will really be imparted to, and increase the swiftness of, the boat, if the Spring exerts its power against the water. The case will be the same with regard to a Cannon-ball, which being shot with a prodigious velocity against the ground, would, nevertheless, receive real addition to this velocity by the action of gravity, though prodigiously weaker than the power that drives it away. From thence I conclude, as I said before, that Art would have, on this supposition, an advantage over Nature, since a duck could add nothing to his acquired swiftness, but by a superior quickness; whereas a Spring will add to the greatest velocity a new one, though much inferior to it. The skill of the Supreme Artificer affords me also room to suspect, that there may be the effect, as it were, of a Spring, in the jerk of a duck's foot, unless one chuse to say, which is likely enough, that he was not designed to borrow a great degree of swiftness from his feet but rather from his wings.

The Oars described in the two foregoing figures will oppose a large superficies to the water, so all the powers of them will be used in forwarding the Boat, which

which is not the case in common Oars. It is well known what is the resistance of water to a great swiftness; it is even superior to that of wood. (See *Desaguliers Cours d'Experim. tom. i. p. 419, 420. l'Edit. Angloise.*)

This principle being admitted, that an Oar must be moved by the unbending of a Spring, this would be a proper place to mention all the examinations I made, to find it out by the easiest and fittest constructions; but, to be short, I confine myself to the mention of the following ones.

I beg it may be well observed here, that, though a man, or any agent whatever, cannot be stronger than himself, he may, upon the water, by the means of a Spring, exert all his strength, whatever degree of swiftness a Boat may be in; whereas he loses a considerable part of it by the common way, which will forward the Boat only by the excess of the swiftness of the Oar over that of the Boat itself.

Fig. III.—Let CD EF be a Boat; the first Oar described above (Fig. I.) may be set to the stern, at the extremity of the Springs IK, or to the sides, according as experience shews it most convenient. The Spring will be bent in drawing AB towards the prow, and they will be afterwards left to themselves.

Fig. IV.—Represents another way, out of many, that may be related; AB raised about B, brings forth an Oar bending the Spring DC against the immovable support D; the Spring, left to itself, will exert its effort against the water.

If it was feared lest these methods should require too great a depth in the water, let this third figure be considered.

Fig. V.—DB and EC represent the mechanism of Fig. II. These are elastic poles or arches with their shelves and cords BD and b E. They will be bent by bringing the cross-line *ab*, by virtue of F. This Construction has these two advantages; 1st. to bring

bring forth the extremities DE, where the greatest strength lies for the unbending; 2dly. By means of a hook in A and b, the Springs may be taken off, which turning round A and b, will float over the water, when it is not deep, or a landing intended.

In the fore part is seen a bow, the extremities of which, bearing Oars, may, by virtue of F, help the working in the stern, or be used instead of it, if the water is not deep enough for that work.

One may easily contrive other shapes of Springs, &c. There are many mentioned in my Book. My design is only to give a sketch of my Work. It is however, material to say, that as the powers F may be brought to act more on one side of the Boat than on the other, they may serve also to resist the stream, and the wind, and ease the rudder, without losing any of its activity. Let it be also remembered, that these Springs ought to be made in such manner as they may be more or less strong and stiff; so that they may, upon occasion, be susceptible of more or less powers requisite to be lodged in them. I shew some models of them in my Book. Now I must describe the powers or agents which I make use of for the bending of these Springs, or the motion of my Oars.

P A R T II.

I Would have it known, first of all, that my great Principle is, that Springs may be considered as a Magazine or Repository of Powers, since they will contain all the powers, either great or small, that are lodged in them, and will let them all out in the unbending. The consequence is, that all mechanical machines that cannot be fit to move a Boat for want of swiftness, may be serviceable, when these powers shall be used in the bending of a Spring, that is to contain, in a manner, the whole of them, and

and let them out all at once. Now there are innumerable physical and mechanical ways to bend such Springs. What powers, for instance, are lost in a ship! It must be granted, that if all the people that are on board were to join together the powers they are capable of, even without straining themselves, the whole of them might be more than sufficient, during a calm, to pull a ship to shore with a rope. This service a spring offers, which was never before thought of. The slow powers, which, on account of their slowness, are of no use when the ship moves, may be exerted with velocity by means of a Spring, and produce their effect. After this observation, which will give great light on this subject, I am going to mention the chief Agents, which, I think, must be made use of to bend Springs. The few things I shall say about them will be sufficient, in my opinion, to convince any man skilled in these matters, that the services I flattered myself of being capable of doing to mankind on several accounts, and especially in Navigation, are not incredible. I have exposed the principal ones in the memoir I had the honour to lay before the Lords of the Admiralty, the 25th of July, 1760. These Agents are chiefly the five following:

- 1st. Men, better employed than in the common way.
- 2d. Cattle; such as Horses, Cows, Oxen, &c.
- 3d. Winds.
- 4th. Gun-powder.
- 5th. The Force of Vapours.

Whatever desire I have to be short, I am sensible this Memoir would be useless, if I were to confine myself to these hints only; I must, therefore, say a few words on each of these articles.

AGENT

AGENT I. Men.

Men may act either by their weight, or by the effort of their muscles. Hitherto they have not been employed in the first respect in Navigation; however, the thing is possible two different ways. I'll mention one in the second article, speaking of the use of living creatures on board of a Ship. The other way will be by means of a Machine, described p. 95 and 96 of my book, which would make every passenger be serviceable with ease in the working of a Ship. Maimed and sick people, women and children, not to mention soldiers on board men of war, every individual would be useful, and contribute to the motion of a Ship, to promote it in a calm, and afterwards increase it.

But the greatest power of men consists in their muscles; and this is a treasure which has not been as yet well known. It is, however, hence that I find the greatest faults in the use of a common Oar; there being many muscles in action at once, both strong and weak, these last render useless the advantage of the first, the effort coming far short of what it could otherwise have been; and there is as great a profusion of vital spirits, even a greater, than if they bestowed the labour upon only the strong muscles; in which case the effort would be double, triple, or even more.

They who have read attentively the excellent book of *Borelli* upon the motion of living creatures, and what Dr. *Desaguliers* says in his Course of Experimental Philosophy (tom. i. p. 281, 282, of the *English* edition), and his whole Annotation on his fourth Lecture, will be convinced, that in men the *Extensores Crurum* are at least six times stronger than the muscles in the Loins. They will see, that whereas he hurts himself in his attempt of raising up 300 lb. weight
with

with these, he and other people that were in his company easily raised up 1900 lb. with the first. And although these *Extensores* seem to work according to the usual method of rowing, what avails the excess of their power, when the weakness of the other muscles cannot come up to it? Just like the strength of a very strong man employed in carrying one end of a very heavy burthen, whilst a very weak man is appointed to carry the other end. Besides, what a profusion of vital spirits to animate all these muscles? I slightly pass over these matters, having treated of them more fully in another place.

To conclude: I employ men to the best advantage, by the *Extensores Crurum*, to the use of which they may join the help of their hands, if it was wanting; and I don't question but practice in this kind of effort would make very easy to them a new kind of work, much stronger than that of common Oars. I would then employ men in the two following ways, which may be adapted to the conveniencies, varied according to the occasion; in a word, may be fitted to the circumstances of a Boat or a Ship, which may be indifferent, provided Men be always set to work in the plainest manner possible by the *Extensores Crurum*, and not by the muscles of the loins alone, or joined to the *Extensores*. In the first method a man would be taken up intire; in the 2d he will keep his hand free, and, if great expedition be not necessary, he may employ his hands. How many sailors, passengers, and others, on board a galley, may use their industry by this means? How many maimed and infirm people, women, even children, might make themselves useful? The least effort will not be lost, all will be an addition of forces, being placed in the Spring, that will apply them to a very good account. Now for the two Methods.

C

METHOD

with these; he and other people that were in his court
 And **METHOD I.** has easily raised up the sail. And
 although these Rovers seem to work according to

Fig. VI.—Let this kind of effort, which is the same as *Desaguliers's* above, be made by one or several agents, and let the Cord B be supposed to be the power bending the Springs in Fig. III. IV. V. On due attention you may observe, that the Oars being supposed wide and well made, the effort on the Ship is almost as great, as if a man from shore was pulling to the Ship with a rope. Let any one compare with this effect the stroke of a common Oar, which is scarce less laborious, and which, like the power of a man who rows, scarce comes to the weight, if the Rower stands, of 27 lb. and if he is sitting, and projecting his feet, is always pretty nearly determined by the strength of the muscles of the Loins.

Such being the power of one or more Rowers, and the service of the Spring, which works almost in the same degree upon and against a running as a still water, it is easy to perceive that one may go up a river this way, but especially by the ways mentioned in the 4th and 5th Articles in the following Part, where I speak of *Gun-powder* and *Vapours*.

and not by the muscles of the loins, as was
 joined to the *Experiment* method a man
 would be taken up into the air, and he will keep his

METHOD II.

If we cast our eyes upon the foregoing Figures III. and V. we easily conceive that men or women may sit in order on a form, the back and seat of which are advantageously disposed to let them have a free use of their feet against the lines AB Fig. III. and vu Fig. V. Neither will it be difficult, in the 4th Fig. to procure, by this motion, the raising of the line AB.

They who have any skill in Mechanism, may find out a thousand ways, according to their taste, or the disposition of a Boat, to vary these constructions,

obviate

obviate the inconveniency of the different length of legs to reach the cross-line, and to place the rowers in a situation that affords a good support for their backs; and keeping them in a posture somewhat inclined facilitates their motions, and frees their hands on a table, to busy themselves about any thing else, if they think proper. I propose divers constructions on that head in my book; but this is not the place for such a detail. I pass on to the second Agent.

AGENT II. *Living Creatures.*

Suppose there are, and it should be proper to have on board of a Ship during a voyage, such Cattle as Horses, Oxen, and perhaps Cows, one easily understands that it will be no difficult matter to make use of them to forward a Ship. It is manifest that cannot be but by their weight, to which service men may contribute, as I said in the beginning of the preceding Article. Here are two different ways to procure that service from Animals. Fig. VII. You only want to bring the line F, or to raise up A Fig. IV. and this may be easily done; the first by putting to the Axis of the Wheel ABC a Handle, Fig. VIII. which, rising, draws up GE by means of the little Hook ED; and which, coming down, discharges it upon F, to let the Spring unbend freely. The second by placing GE perpendicularly, and supplying the action of Gravity by a light Spring, that presses GE against the Handle. If the Wheel is wide enough, one may add Men to an Ox or Horse in this motion; and if the outside is set with cross-sticks like the steps of a ladder, two or three Men may act with all the advantage of the biggest lever, going up the Wheel as a ladder, using all their weight, or pulling the rounds downwards, their back being able to strive harder upon occasion.

I do not enter upon the calculation or estimation of these forces; it would be useless to those who are

versed in these matters ; and it is enough to make those, who are not so well acquainted with them, observe, that these are real forces ; and, after what I have said above, they will easily conceive that, whatever these forces may be, they are really and intirely employed in forwarding the Ship by means of the Springs, in what swiftness soever the Ship should be.

The second way to employ Animals in the progress of a Ship is the following ; but, before I describe it, I must explain a Machine which I contrived several years ago, to procure a motion in one and the same direction, whether the efficient power acted according to that direction, or in a quite contrary one. I was trying then to use the rise and fall of mercury in the bowl of a barometer, in bending a Spring to set a clock going.

If the Basis ABCD, supporting the Frame AHFB, is supposed to float on mercury, which undergoes vicissitudes of rising and falling, it must rise and fall ; but by contrary direction of the *dented Spring* in H and in F, whether it rises or falls, it will carry on the same side F the Wheel, or rather Barrel E, containing a Spring. The sight of the figure is sufficient to shew, that in the fall of the mercury, the dents F work, and the others yield, and that on the contrary these last work, when the mercury rises, whilst the first bend. This mechanism, fitted to the intention I had then of making a clock that should not require winding up, may be serviceable in many occasions. I make use of it here. Fig. X.

Let AEB a steady floor, viz. the deck of a Ship, to be fastened firmly in A and B by iron hooks, which, being unhooked, may ballance on the iron bar EM, so that the part B falls down to D, or A to C. CD is another immoveable deck, about one foot and a half or two foot distant from the other. Let there be along both sides of the deck AB two
ridges,

ridges, in which two iron globes, each of them 200 pounds weight, may roll freely, and a very stiff Spring, on both ends of each ridge, to break the *Action*, when the globes reach it.

Again, suppose the globes being in A, about ten men, besides an Ox, placed on the side B, it will have a load of about 1400 pounds, and sink, and the globes rolling on the same side B, will bring an additional weight of 400 pounds, without any danger, on account of the Springs that are to absorb the motion of them.

It is then evident that there is a power equivalent to 1800 pounds at least, which may easily be carried farther, for one may use much heavier globes; it is enough if they are not quite so heavy as the power that is to bring them up. Besides, one or two Men may be employed in A or B by the effort of the Fig. VI, so much greater than their own weight: so that, upon occasion, it may be easy to carry the effort to 2000 pounds, a weight more than sufficient to give a good motion to a Ship, or keep her in it, if it pull her with a rope.

But as I have proved, that the construction of my Oars and a Spring have near the same effect; it is manifest that it is possible to give, that way, a considerable addition to the swiftness of a Ship, and to forward her in a calm.

Let, indeed, EF be an inflexible iron bar, which described being fixed in the middle of Axis EM, an arch of a circle *versus* B; let it go freely in the hole F of the piece FG (which is the frame of Fig. IX), which being fastened along two iron rules, may slide freely, and be carried forward and backward by the motion of the bar EF.

In the balaneing of the deck, the Wheel E, which is the same as the Fig. IX. will receive a constant progress, and may go half round, being contrived for that purpose, so that it will pull, by the whole

whole length of its diameter, what is tied to a point, such as O.

From thence it is easy to have this effort, to bring the lines AB of the Fig. III. or UV of the Fig. V. to bend Springs, and set the Oars to work. One must only use this caution, that, after the effort, the Spring may always recover itself, and unbend freely.

I do not describe here these particular mechanisms, because it would be too prolix, and hard to be represented; but any skilful workman may execute them as he pleases. It is enough to give him the Powers and a Spring, and he will make good use of both.

I come now to the third agent, which I employ in the progress of a Ship, namely, the Wind.

AGENT III. *The Wind.*

The Wind is often contrary; sometimes it blows too hard; sometimes there is no wind at all. Is it impossible, in the first case, to weaken and almost destroy its action on a Ship, and place the Ship very nearly in the condition of a calm? Is it impossible, when there is too much wind, to get from it a supply of *forces*, to use them upon occasion with economy? Is it impossible to take a greater advantage of them than is usual, and make them conduce to the safety of a Ship; to exercise arts on board a ship, to ease the pump; and, may be, to distill naturally the sea-water, that might afford a certain quantity of fresh water, which would be a great and useful resource upon occasion? I am going to propose my notions and conjectures thereupon; very ready, however, to rectify them, when I am made sensible of my mistake,

QUÆRE

QUESTION 1.—Is it impossible to diminish or almost destroy the action of a quite contrary wind on a Ship?

I have contriv'd a Cart, that moves forward against the Wind, with so much more velocity as the Wind blows harder, and by the mechanism of its wings, when I sit on it, I command the displaying and situation of them in such a manner, that I move which way I please, with more or less swiftness, let the Wind be in any part of the compass. You may see the description of it p. 31, 40, 41, 63, of my Book.

This mechanical invention might induce one to think that it would be possible to navigate directly against the wind, by the only effort of the Wind itself. I judge this impossible on water, but I believe very possible to diminish considerably the action of the Wind, and then overcome her by superior force.

Let the prow of a Ship be turned against the Wind, and wings like the sweeps of a wind-mill, and as large as the surface of the Ship opposite to the Wind, cover the Ship, the stress of the Wind will intirely lie on these Wings: but if they are contriv'd so that they bend Springs, that strike the Sea, on the contrary side with broad Oars, then the impression of Wind will be made intire upon these Wings; and if they form, for instance, an angle of 45 degrees*, this force being divided, will give two equal ones, one of which will drive the Ship backwards whilst the other applied to the Oars, would intirely destroy itself, if the resistance of the water on the return of the Oar, and the frictions did not abate it in some degree; so that,

* The most advantageous angle is that of 54 degrees, 44 minutes; this is made choice of to render the example more easy.

by this mechanism, one might lessen almost by one half the impression of a direct contrary Wind.

But the powers which I have mentioned in the two foregoing articles, fully enabling one to overcome this remainder of action of a contrary Wind, I think one may proceed directly against the Wind, if the sea and the good condition of the Ship allow it, for she will undergo considerable efforts by these contrary powers. This will bring along with it a fuller conviction, when I have treated of the two last agents which I believe may be used in Navigation. I don't describe here the mechanism of this operation. They are in my Book.

QUÆRE II.—Is it impossible, when the Wind blows fair, or even too hard, to get from it a supply of forces, which may be used with œconomy upon a necessary occasion?

I answer, That it appears to me that, by substituting in the room of common sails those I have contrived, pretty near like the sweeps of a wind-mill, a Ship would admit the same impression of Winds, and bend at the same time strong Springs, that might be either employed or reserved as a resource during a calm. These Springs might be bent in the harbour, whilst the ship lies at anchor, or she sails with a fair wind. I do not describe here my mechanism in this respect. It is to be found in my Book.

QUÆRE III.—Is it impossible to take a greater advantage of the Winds than is commonly done, and make them subservient to the safety of the Ship, to exercise arts on board a Ship, to ease pumps, and, perhaps, to procure a little fresh water?

I think I may with certainty answer in the affirmative to these questions, except to the last, about which I have only probable conjectures. There are on land wind-mills, wind-saws, why not on the sea? A sail used to such a purpose would conduce no less to the motion of the Ship. Many goods, or commodities

modities are imported into *Europe*, that might be wrought or prepared on board a Ship in the voyage. The work of the pumps particularly is a service to be received from the Wind. As for the salubrity of the Ship it is obvious, that the before-mentioned sail might continually freshen the air by setting to work a large bellows, that would blow into all the lower parts of the Ship a fresh air from without. All these uses can only be mentioned in this Memoir, which grows too long, instead of giving only a notion of my Work.

As for fresh water to be procured on the sea, the following is my opinion. Evaporation being proportioned to the surface, which fluids expose to the impression of the air, winds, and heat, and knowing by experience, that water well broken, and reduced to very small particles, by a contrary obstacle, a very strong and rapid spout, evaporates very much. Knowing besides, that saline particles, being the heaviest, hardly evaporate; I contrive on these principles a machine moved by a winged sail, that conveys seawater through a syringe with violence, and breaks it against a wheel, which makes it still less; and this operation being made in a canal, which admits a high wind, and all the heat of the Ship and kitchen, I think that fresh water may be separated and conveyed, by the very construction of the canal, into a reservoir. I leave to experience to verify or contradict my conjecture. But enough on this article. I come now to the two last and most powerful agents, which I believe may be employed for the service of Navigation; *viz.* Gun-powder and Vapours.

AGENT IV. *Gun-powder.*

It is obvious that Gun-powder has a prodigious power in its explosion; however, I never heard that any body ever thought of making use of it in mechanics,

chanics. Why not? For the very reason that has prevented men for so long a time, at the sight of impetuous torrents, from conceiving the real services which they might procure from the powers of running waters. They joined to Gun-powder still more than to torrents a notion of violence and destruction incompatible with moderate and regular motions, and they seldom used it but to the destruction of mankind.

I imagined, about twenty years ago, it was possible to bestow it upon better services. I even contrived then a machine that may be useful. But, properly speaking, it was only since the discovery of my Great Principle that I understood all the extent and the value of the services men may receive from this matter, that seems to be invincible. This Principle is that one may consider Springs as Repositories of Force, and make them restore with violence, or with weight and measure, any Power whatsoever bestowed upon them. I easily conceived, by means of this Principle, that a Spring charged by the explosion of Gun-powder, would no less upon this account be governed by the compass and direction of a natural philosopher, for distribution of the power it contains, than if it had been bent by any other means. I had then nothing to do but to find out the way to apply this power in the tension of Springs that could contain it. After many Experiments, I pitched upon the following machine, from which I borrow a great many uses for Arts, Works, embellishing of Towns, and the country, and, above all, for *Navigation*. It is especially from the application of this prodigious power, and of the Vapours of boiling water, that I promise to Navigation the advantages proposed in my Memoir *, and particularly the last of the second article, and the first and third intirely.

* *Supra*, p. 7.

I beg leave to make here an observation. It would certainly be a presumption in me to attest that nobody before me had ever had the notion of employing these Agents the same way as I do; but I protest that, if it is so, I am ignorant of it, and that I took the idea of my work from nobody. This is what any impartial Judge may easily acknowledge, by the perusal only of my Book, in which one sees, at different intervals of time, more or less considerable, (as the circumstances of a man, taken up with other objects, requires it), one sees, I say, the first sketches of the invention, errors, improvements, the progress and the end of a primitive Work. It is what has induced me to take, in relation to this Book, the precautions, to which the Lords of the Admiralty, and many other respectable Gentlemen, have been pleased to condescend, in order to warrant to me the merit of the invention, before I should publish my work, and my principles should become known, and in the hands of Gentlemen more learned than myself. I desire all equitable persons to believe, I had some reason to act in this manner, drawn from considerations more honest and suitable to the character I have the honour to be invested with, than the mean views of a contemptible vanity. I durst flatter myself, that discoveries so useful to mankind in general might be so to my family, and I ought, upon that account, to secure to my Work the character of an original, in what intirely belongs to me.

It is true, an honourable Gentleman, one of the Members of the Navy Office, told me when I appeared before them on the 4th of *August*, 1760, that about thirty years ago, a *Scotchman* proposed to make a Ship sail with Gun-powder; but having found by the experiments made for that purpose, that thirty barrels of Gun-powder had scarce forwarded the Ship the space of ten Miles, this Invention had been rejected. To this I answered, that he acquainted me with

a thing quite new to me ; that his Scheme was deservedly rejected, but that my Work was of another kind. I have been told since, that it was from the power of retrogradation of one or more Cannons on the poop, this man had conceived the hope of forwarding a Ship. This put me in mind of the trial, a celebrated Gentleman made many years ago, to set a Boat going on the *Rhine*, by the effusion of the water from a tub on the stern, by a hole towards the prow. This was only a sport. As for the *Scotchman's* work, one may easily see that it has nothing common with mine, but the thought of Gun-powder. The following description will make it still more clear and explicit.

The Machine I am going to describe, requires an explosion at every stroke of the Oars, which seems to demand too great expedition in the loading again. Whereupon I beg my reader to consider, 1st. This quickness may very possibly be effected by the construction of the machine ; and, moreover, 2dly. I have contrived an amendment to this fault, by means of which one explosion of powder will occasion four, five, six, or more strokes in the Oars. This second machine is described in page 85 of my book ; but I do not believe it very necessary. Every one knows how quick a *Prussian* soldier is in loading his gun after a discharge, though this operation is much more troublesome, than that of the machine following, to which it is possible to add, and I myself could do it, some improvement, such as a Fire-lock.

Fig. XI.—RSOP is a brass Cannon, the inside of which may be well polished. Its cavity ECOP, is terminated by a circle that is screwed up in the extremity, has a round bore in OP, and inwardly a strong Spring, in a spiral form, to break the remainder of the power H, that might otherwise burst the bottom. On the other side of the Cannon, the cavity is narrower to form the chamber, TEUC, the part of which

which, TUBD, ought to be well screwed up inwardly. In that chamber is the screw A, by which the capacity is determined according to occasion and circumstances of the Ship, after due Experiments. EF is the touch-hole, made in the shape of a funnel; its opening must be large, as it serves also to fill with powder the chamber DBEC. But, before it is fired, a turn of the screw G will confine it to a just extent, that it should not spend too much power in firing. HI is an iron bar ending in H, by a cylinder turned, which suits and fits the bottom of the chamber. When it reaches, by the power of fire, the end of the cannon, it is stopped there by the bottom OP, and by the Spring, without any risk of its bursting out, because the openings NN that surround the cannon, and which, taken together, have a larger surface than the natural opening at the bottom, leave a free passage to the power of the fire. LM is a bar that crosses HI, to bring back by Springs, or the ropes LK, MK, the Piston H exactly into CE, and even with support, which will be by means of the weights K, or Springs known by experience. This granted, HI will go forward and backward as often as it may be possible for a man to load a cannon, and the power I, will be applied in bending the Springs of the Oars I have described above. And the Oars (save the deduction of the resistances), will work on the water with all the power of the powder. They who know this power, and considers the simplicity of this Mechanism, will not be afraid of an immoderate expence. Experience may determine it by the cargo of the Ship, and the degree of swiftness one intends to bestow upon her. As a certain time will be requisite for the Spring to unbend, especially if the Oars are broad, as I would have them, the bar HI will be made so, that the Piston may return immediately, in order that the loading may be made during the unfolding of the Oars.

The

The way to do it is very plain, half a turning of the screw G, to enlarge the touch-hole, fill with powder up to F, diminish the touch-hole, and fire.

Upon occasion, the Springs made stronger, and the Oars broader, a turning of the screw A, to enlarge the chamber, all these together may accelerate the motion of the Ship, resist a stream, a contrary wind, and, in carrying the whole to the utmost, be able to give to the Ship that kind of motion which I have compared to *Horror* in Creatures.

One may, during a voyage made the common ways, have the power of keeping the Oars in an extreme tension so as to strike that *Horror* upon an occasion. It is needless to say the Cannon must be steady and immovable. My opinion is, that its natural position must be the 2d deck on a Ship, as that of the Oars is in the stern. But the seamen may be proper Judges, and adapt it to their own conveniencies. It is enough to a Philosopher or a Mechanic to furnish them with sufficient Agents and Machines to move their Ship. I might say a great many other things about this matter, but this may sufficiently shew the Use and Certainty of my Work, which was the end of this Memoir. Now I come to the fifth Agent I have mentioned.

AGENT V. *The Vapours of Boiling Water.*

It is to be wished any one had tried to know precisely the power of the Vapours of Boiling Water. The marquis of *Worcester*, who first discovered it, Captain *Seury*, and even Doctor *Desaguliers*, seem to have contented themselves, with knowing that this power was very great, without attempting the nice Experiments that were necessary to determine it. My situation hitherto having not allowed me to satisfy myself in that respect, I'll suppose with them this power very great, and confine myself to discover the way to take an advantage of it for the course of
a Ship.

a Ship. Experience alone may decide which will be the safest, the least expensive, and the most convenient to use for that purpose, either Gun-powder or Vapours. I shall only explain by what mechanism it may be expected from both.

Fig. XII.—To this end here is the machine I propose. ABFG is a Copper, under which is a coal fire E: there is in H a Spring, which only rises up the moment when it would be dangerous, lest the Vapours should burst the machine. The cocks A & will give notice when there is water enough in the Copper. This Copper supports the Pump OH. There is in H a Cock KL, that opens or shuts the the communication between the Pump and Copper. The Cock has its branch IA on one side, and branch L on the other side, both being elastick. Moreover the bar MN is fixed in M, with the ball N on the top, and curbed between X and Y by the strings. In the Pump is a Sucker, the stiff bar of which turns in the extremity O, of a branch perpendicular on the cross-line ST. On another branch in R is placed the bar RA, and on the cross ST, is the branch U, in which the end of the bar UX, may be stopt with a Screw in a convenient height. Q is a reservoir of cold water, that is always full, to furnish in P with a Cock a little water on the Sucker, and especially to inject some upwards within the Pump. * is a Cock which is opened or shut by the motion of the branch fastened on the extremity of the Cock KL. Which being premised, this is the work of the machine. The Vapours raise up the Sucker of the Pump, and draw along RA, for first bending the Spring IA, that turns the Cock KL only, when its tension is considerable, and the Sucker has almost reached the top of the Pump. There is a great advantage in this; it quite opens or shuts the Cock, and there may be no occasion for MN. Then the spring sufficiently bent will turn Cock KL, and bring N beyond

yond the perpendicular, to help by a jerk the intire shutting of the Cock. So KL stops the new Vapours of the Copper. But at the same moment, this Cock is shut, the branch L opens the Cock of injection $\times$, through which there will be a little sprinkling into the Pump, that will let loose the Vapours. Then the Sucker falls, and the Spring IA is bent again, and, bringing back the Ball N, opens again the Cock KL, and shuts the Cock of injection $\times$. Then every thing will be ready for another stroke. In this motion it is obvious, that UX, that bends the Oars will make a greater or less progress, according to the height wU , which is to be raised as much as possible. One must be directed for this by the time necessary to the Oars to exert their power, and adapting as much as possible this time to that, which is between the actions, or strokes of this Fire-engine.

It is enough, I think, to give a general notion of the Agents that I would employ in the service of Navigation, and of the ways in which the affair is practicable. But although my circumstances have not allowed me to carry my inquiries and experiments so far as I wished, and I am disposed to do, but only so far as it was necessary to convince myself of the certainty of my principles, and of the main applications of them; I must, however, say, that this is but a sketch of a larger Work, which may be no less useful to Arts, Trades, Carriages, and divers Wants of Society, than to Navigation itself, to which I ought to confine myself in this Memoir*. This will be made appear by a Table of Chapters of my Book, which shall be the conclusion of this Memoir.

* The Author having presented his Book to the Honourable Commissioners of the Navy Office, on the 4th of August, 1760, has been desired to comprise in a short Memoir, as much thereof as appertained to Navigation.

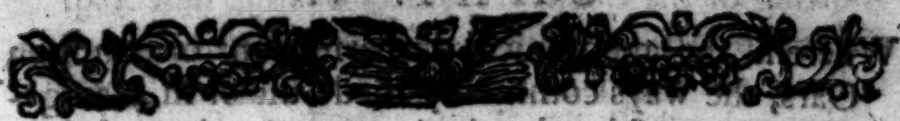


TABLE of the CHAPTERS.

**Differtation upon the Wonders of the Mechanism
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to which it was very easy to give attention.**

CHAPTER III.

**Of rapid motions, wherein is occasionally treated of
the flight of birds, of the motion of fish, and cer-
tain insects that move with wings over the surface
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Observations upon elastic subjects, and the shapes
more or less advantageous, that may be given to
them, wherein mention is made of Bows, Oars,
&c.**

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C H A P. VI.

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C H A P. VII.

Inquiries to be made about the use of a Fire-engine to supply human work on the sea.

C H A P. VIII.

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C H A P. IX.

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Application of the Great Principle to Wheel-carriages, Husbandry, and Arts.

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C H A P. XV.

Of House-mills, their Construction, how to gather, whilst the Wind blows, Powers sufficient to move them when it ceases.

C H A P. XVI.

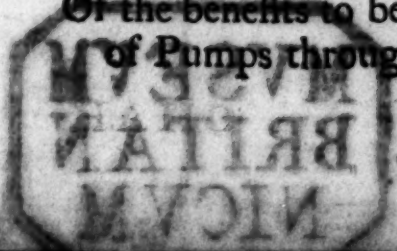
How to give the Wind-mills an uniform motion.

C H A P. XVII.

How to change Wells into Springs, to drain Marshes, to empty Mines, and to procure prodigious Efforts upon occasion.

C H A P. XVIII.

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passengers, the admitting fresh air by an excellent Ventilator, of Sails turning without any loss of the Wind's impression to forward the Ship.

C H A P. XIX.

How many Powers are lost on board of a Ship ; the ways to apply them to her benefit. The use of maimed People, Women, Children, and Cattle, to that end.

C H A P. XX.

How to accelerate the progress of Men and Cattle. Description of a very advantageous Cart and Plough upon these principles.

C H A P. XXI.

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C H A P. XXII.

Essay on a Machine which might be serviceable in calculating the way a Ship has made.

C H A P. XXIII.

Conclusion ; wherein the Author shews that his Principles open a new and immense Career in Mechanics, and that it will be easy to make such application of them, as did not occur to him ; and wherein he invites, by the success of his Inquiries, those whom Providence has placed in more favourable circumstances, and on whom are bestowed superior talents to search into the study of Nature, for the Models of the most perfect and marvellous Mechanisms.



Fig V

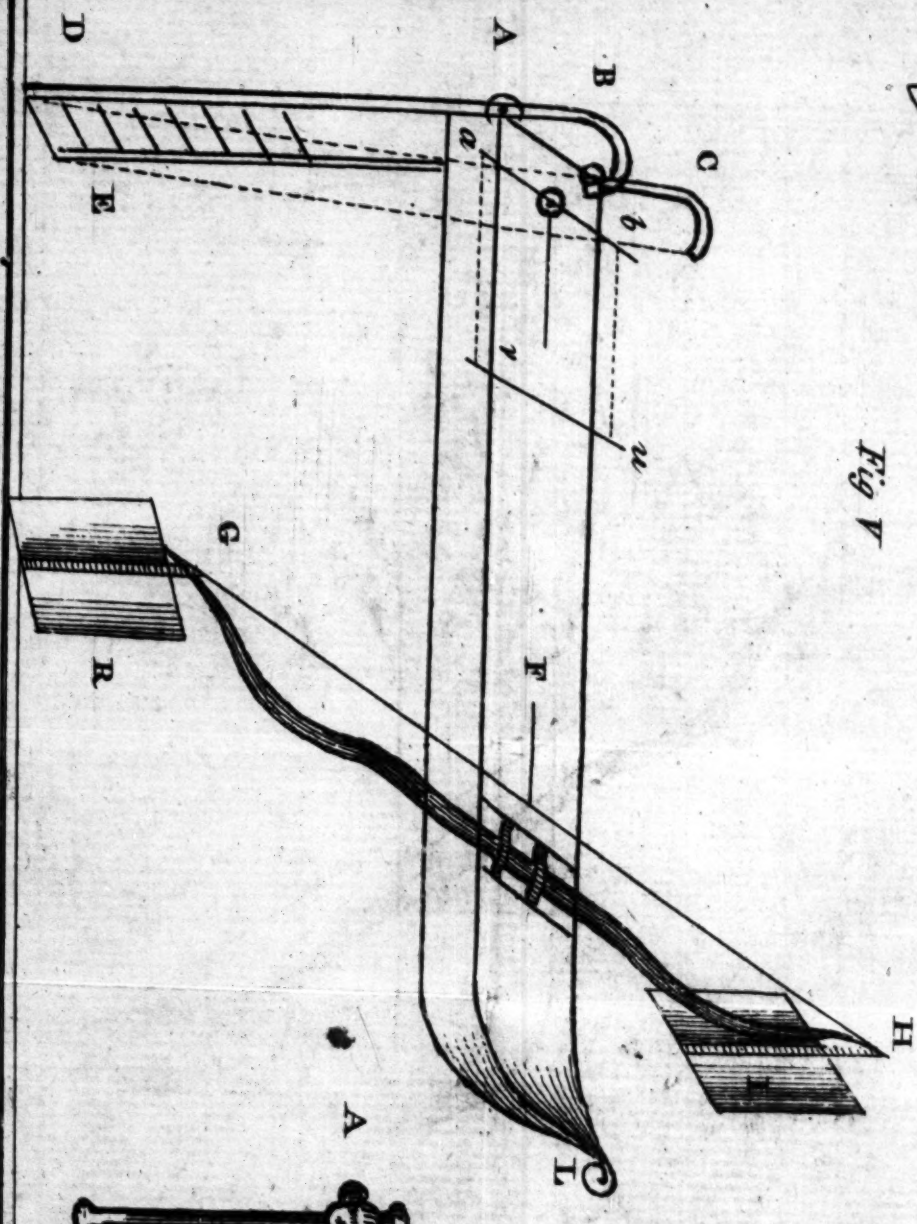


Fig X

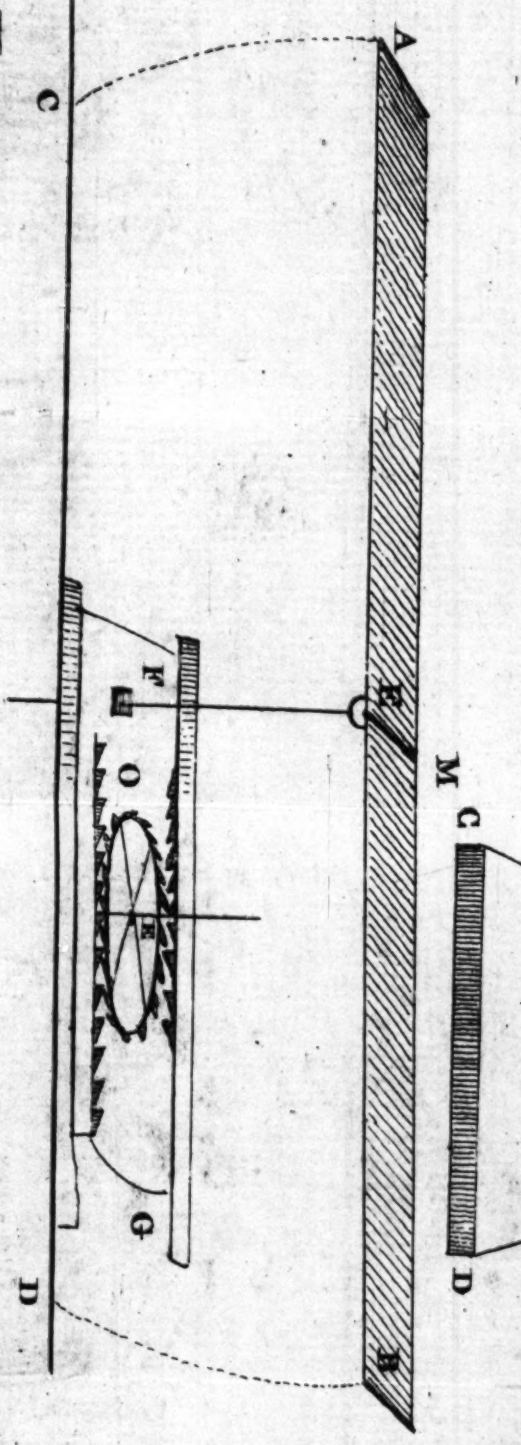


Fig XI

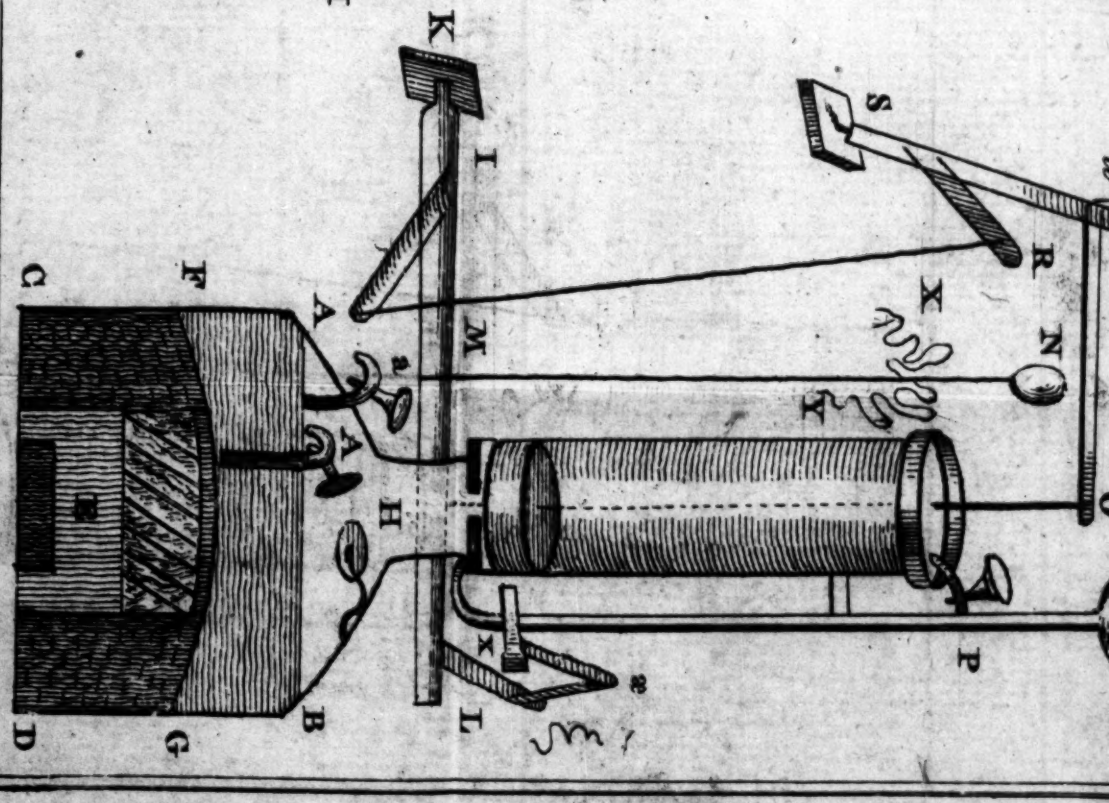
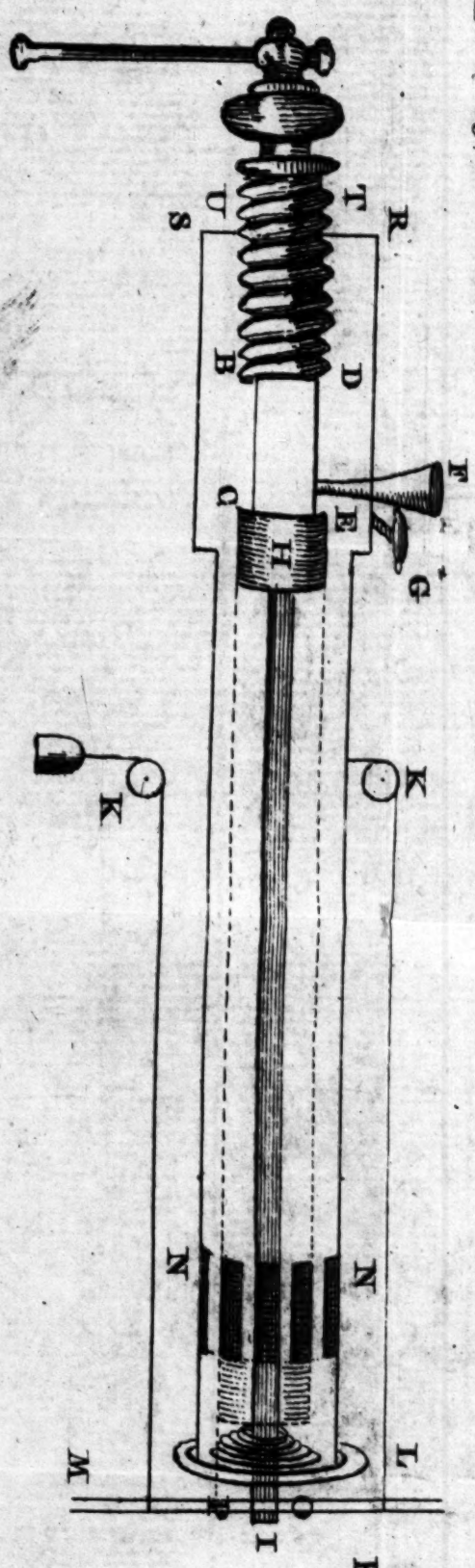


Fig I

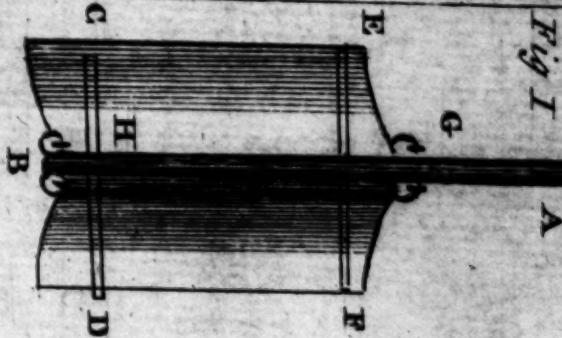


Fig II

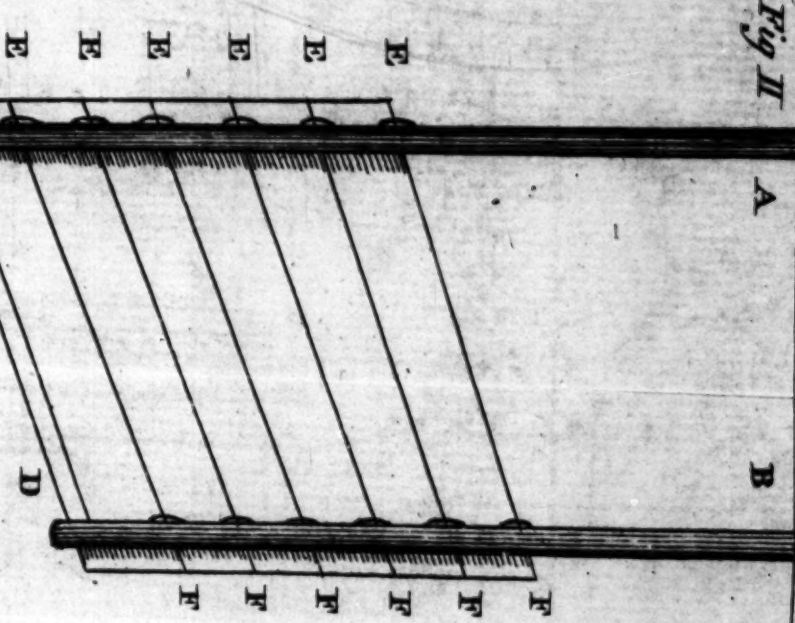


Fig IV

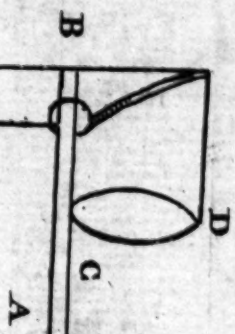


Fig VIII

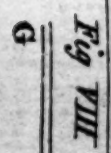


Fig VII



Fig III

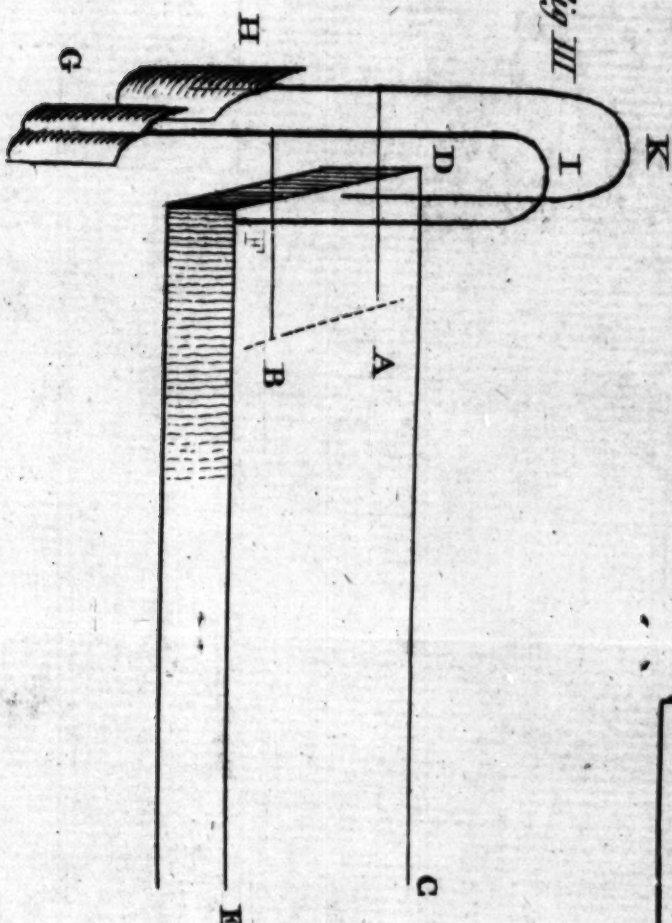


Fig IX

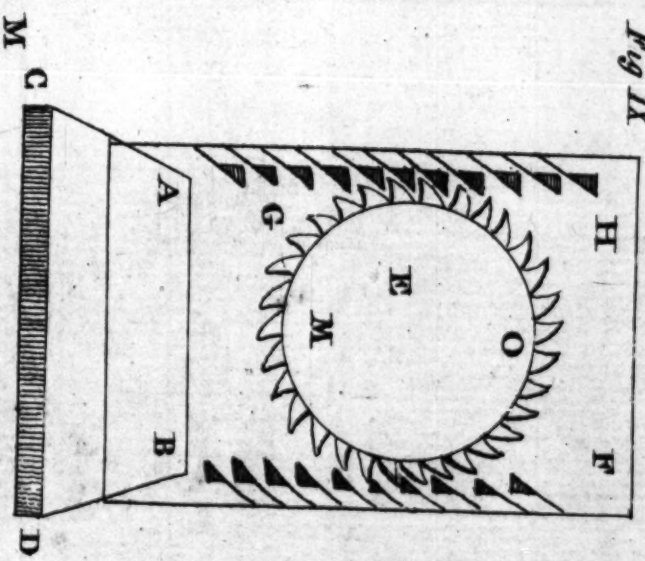


Fig VI

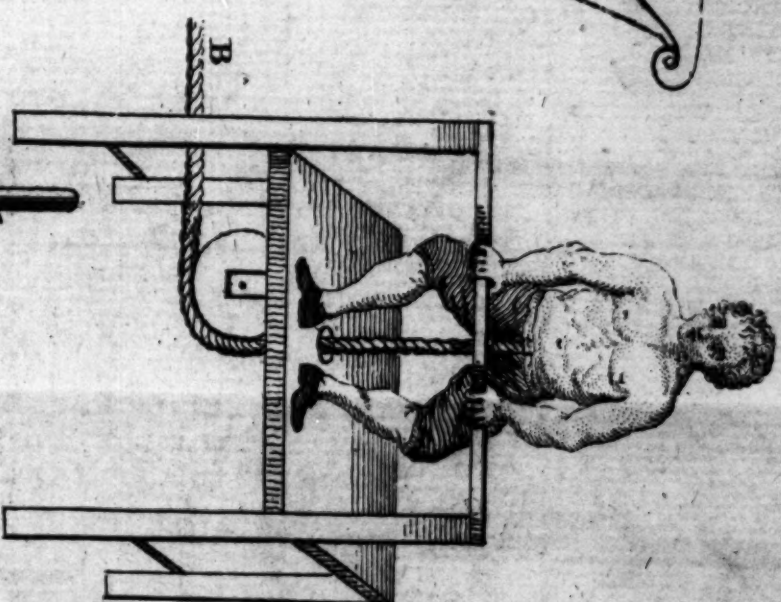


Fig XII



Fig X

